

CLAIMS:

1. An apparatus for controlling a throttle opening degree, which is an opening degree of a throttle valve of an internal combustion engine mounted on a vehicle, wherein the vehicle has a driving system coupled to an output shaft of the internal combustion engine, the apparatus comprising:

10 a controller, wherein the controller sets a target value of the throttle opening degree based on a depression degree of an acceleration pedal provided in the vehicle, wherein the controller gradually changes the throttle opening degree at a predetermined gradual change speed such that the throttle opening degree reaches the target value, and wherein a rotation speed of the output shaft changes in accordance with 15 changes in the throttle opening degree,

wherein the controller limits the gradual change speed of the throttle opening degree for a predetermined period such that a changing speed of the rotation speed of the output shaft is suppressed at a reverse time when a direction of 20 torque transmitted between the driving system and the output shaft is reversed.

2. The apparatus according to claim 1, wherein the driving system includes an input shaft and a coupling mechanism, wherein the coupling mechanism couples the input shaft to the output shaft while permitting the input shaft and the output shaft to rotate relative to each other, and wherein the controller recognizes a reverse of the direction of torque based on switching in the order of the values of the rotation 30 speed of the output shaft and the rotation speed of the input shaft.

3. The apparatus according to claim 2, wherein, after the order of the values of the rotation speed of the output shaft and the rotation speed of the input shaft is switched and when

the difference between the rotation speeds reaches and surpasses a predetermined value, the controller terminates a control for limiting the gradual change speed of the throttle opening degree.

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4. The apparatus according to claim 2, wherein the controller sets a first throttle opening degree that corresponds to a rotation speed of the output shaft before the order of the values of the rotation speed of the output shaft and the rotation speed of the input shaft is switched and when the difference between the rotation speeds is decreased to a first predetermined value, and wherein, when the throttle opening degree reaches the first throttle opening degree, the controller starts a control for limiting the gradual change speed of the throttle opening degree.

5. The apparatus according to claim 4, wherein the controller sets a second throttle opening degree that corresponds to a rotation speed of the output shaft after the order of the values of the rotation speed of the output shaft and the rotation speed of the input shaft is switched and when the difference between the rotation speeds is increased to a second predetermined value, and wherein, while the throttle opening degree is changing from the first throttle opening degree to the second throttle opening degree, the controller causes the gradual change speed of the throttle opening degree to be less than the changing speed of the target value.

6. The apparatus according to claim 5, wherein the controller sets the first and second throttle opening degrees according to the rotation speed of the input shaft.

7. The apparatus according to claim 6, wherein the driving system includes a transmission, and wherein the controller sets the first and second throttle opening degrees

according to the gear of the transmission.

8. The apparatus according to claim 5, wherein, when the throttle opening degree reaches the second throttle opening degree, the controller starts a control for maintaining the throttle opening degree at the second throttle opening degree.

9. The apparatus according to claim 8, wherein, until the difference between the rotation speed of the output shaft and the rotation speed of the input shaft reaches a predetermined value, the controller maintains the throttle opening at the second throttle opening degree, and thereafter, the controller causes the throttle opening degree to reach the target value.

15 10. The apparatus according to claim 9, wherein the controller limits a period in which the throttle opening degree is maintained at the second throttle opening degree within a predetermined time limit.

20 11. The apparatus according to claim 10, wherein the controller sets the time limit according to the depression degree of the acceleration pedal.

25 12. The apparatus according to claim 10, wherein the driving system includes a transmission, and wherein the controller sets the time limit according to the gear of the transmission.

30 13. The apparatus according to claim 1, wherein, during the predetermined period, the controller decreases the gradual change speed of the throttle opening degree as time elapses.

35 14. The apparatus according to claim 13, wherein the controller decreases the gradual change speed of the throttle opening degree to zero as time elapses.

15. The apparatus according to claim 13, wherein, during the predetermined period, the controller first causes the gradual change speed of the throttle opening degree to be less
5 than the changing speed of the target value, and then maintains the throttle opening degree at a fixed value that is different from the target value.

16. The apparatus according to claim 15, wherein the
10 controller limits a period in which the throttle opening degree is maintained at the fixed value within a predetermined time limit.

17. The apparatus according to claim 16, wherein the
15 controller sets the time limit according to the depression degree of the acceleration pedal.

18. The apparatus according to claim 16, wherein the driving system includes a transmission, and wherein the
20 controller sets the time limit according to the gear of the transmission.

19. The apparatus according to claim 1, wherein the controller limits a period in which the gradual change speed
25 of the throttle opening degree is limited within a period that corresponds to the depression degree of the acceleration pedal.

20. The apparatus according to claim 19, wherein the
30 controller sets the period in which the gradual change speed of the throttle opening degree is limited to be shorter for a greater depression degree of the acceleration pedal.

21. The apparatus according to claim 1, wherein the
35 driving system includes a transmission, and wherein the

controller limits a period in which the gradual change speed of the throttle opening degree is limited within a period that corresponds to the gear of the transmission.

5 22. The apparatus according to claim 1, wherein, when the throttle opening degree reaches a predetermined value, the controller terminates a control for limiting the gradual change speed of the throttle opening degree.

10 23. The apparatus according to claim 1, further comprising a throttle sensor, wherein, to control the throttle valve, the controller uses a throttle opening degree that is computed by adding a predetermined offset value to an opening degree of the throttle valve detected by the throttle sensor, 15 and wherein the offset value is set equal to or less than a change amount of the target value during a period of a response delay of the detected throttle opening degree relative to the target value.

20 24. An apparatus for controlling a throttle opening degree, which is an opening degree of a throttle valve of an internal combustion engine mounted on a vehicle, wherein the vehicle has a driving system coupled to an output shaft of the internal combustion engine, the apparatus comprising:

25 setting means that sets a target value of the throttle opening degree based on a depression degree of an acceleration pedal provided in the vehicle; and

30 controlling means for controlling the throttle valve, wherein the controlling means gradually changes the throttle opening degree at a predetermined gradual change speed such that the throttle opening degree reaches the target value, and wherein a rotation speed of the output shaft changes in accordance with changes in the throttle opening degree,

35 wherein the controlling means limits the gradual change

speed of the throttle opening degree for a predetermined period such that a changing speed of the rotation speed of the output shaft is suppressed at a reverse time when a direction of torque transmitted between the driving system and the
5 output shaft is reversed.

25. A method for controlling a throttle opening degree, which is an opening degree of a throttle valve of an internal combustion engine mounted on a vehicle, wherein the vehicle
10 has a driving system coupled to an output shaft of the internal combustion engine, the method comprising:

setting a target value of the throttle opening degree based on a depression degree of an acceleration pedal provided in the vehicle;

15 gradually changing the throttle opening degree at a predetermined gradual change speed such that the throttle opening degree reaches the target value, wherein a rotation speed of the output shaft changes in accordance with changes in the throttle opening degree; and

20 limiting the gradual change speed of the throttle opening degree for a predetermined period such that a changing speed of the rotation speed of the output shaft is suppressed at a reverse time when a direction of torque transmitted between the driving system and the output shaft is reversed.

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